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RPPR Final Report
as of 24-Oct-2017

Agency Code:

Proposal Number: 69266LSCF **Agreement Number: W911NF-16-1-0157**
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DUNS Number: 074816851 EIN: 520700497
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Report Term: 0-Other
Submitted By: Brent Ramsey Email: srcgrants@faseb.org
Phone: (301) 634-7156
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STEM Degrees: **STEM Participants:**

Major Goals: Major Goals of the Project
The overall goal of this project was to provide support for the 2016 FASEB Science Research Conference on Virus Structure and Assembly which was held July 24-29, 2016 in Steamboat Springs, CO. This event was the latest biennial meeting, part of a 20+ year series which has become the premier scientific gathering for structural virology. Traditionally the meeting highlights the biophysical approaches that are used in the field, along with biochemistry and molecular genetics, to understand all aspects of the virus lifecycle: host recognition and binding, entry, intracellular trafficking, viral uncoating, replication, assembly, maturation and exit. These topics are explored in formal talks, poster sessions, and intensive scientific discussion. The FASEB Virus Structure and Assembly conference series is distinctive and exceptional by its pursuit of the following objectives:
• Highlight diverse disciplines in virology. One third of the attendees are primarily structural virologists exploiting X-ray crystallography, NMR, cryo-electron microscopy and other biophysical techniques to drive the field forward. Other attendees cover a breadth of disciplines including genetics, cell biology, biochemistry, and theoretical analyses of virus assembly. Cross-pollination of ideas leads to fruitful collaborations at the interfaces of techniques. It is rare to get such diverse group of scientists under one roof except at this conference series.
• Present a breadth of topics. While virology meetings are often dedicated to a single virus, the FASEB Virus Structure and Assembly Conferences typically present and discuss over 30 different viruses and bacteriophages. This mixing of topics and disciplines has led to outstanding results, such as the realization that phages and human viruses (e.g., herpesviruses, adenoviruses and others) have common structural protein folds and therefore common ancestors. Such insights would not arise from focused meetings, but impact the field enormously by revealing how easily studied and manipulated systems (phages) inform the understanding of the more complex and biomedically important (human viruses).
• Bring together an international community of scientists. All previous meetings have been attended by a large percentage of scientists from outside the US, providing a forum for international exchange. The current meeting is no exception.
• Provide an outstanding environment for scientific discussion. Considerable time is dedicated to both formal and informal scientific discussion, enhancing the research of all attendees and facilitating the creation of new collaborations.
• Provide outstanding opportunities for young scientists. The meeting is limited to 175 conferees. A large number of these slots are reserved for young scientists at the graduate, post-doctoral and assistant professor levels. Young faculty are included in the list of plenary speakers, and graduate students and postdoctoral scholars are chosen to present short talks. The two large poster sessions include presentations by researchers at all levels, and are extremely well attended. “Meet the Expert” lunches give access by younger scientists to more senior researchers, and these have functioned well in previous years.

RPPR Final Report
as of 24-Oct-2017

A recent trend in this conference series is to craft a theme around which speakers and their subjects are selected. The previous meeting in 2014 was focused on the structural basis of interaction between virus and their environment and included two special sessions: the role of environment in viral evolution, and the chemical modification of viruses to create new environments and technologies at the nanometer scale. The recent explosion of structure-based virology suggests that this is constricting as new technologies accelerate progress in all areas of this conference. However, we will maintain two special sessions to recognize novel and unifying developments in the field: Viruses as Tools, and Virus Evolution and Genomics.

Accomplishments: Accomplishments

Major activities:
The FASEB Science Research Conference on “Virus Structure and Assembly” was held successfully at its new FASEB-chosen site of The Steamboat Grand Resort, Steamboat Springs, Colorado, on July 24-29, 2016. Despite the new and more expensive location, attendance was strong, numbering 123 PIs, post-docs and students.
The primary activity was the series of 48 talks starting Sunday afternoon and running through Friday noon. The final agenda covered a wide breadth of work featuring the use of state-of the-art technologies to investigate viruses that ranged from important human pathogens (influenza, hepatitis B and C, HIV, Ebola and Zika) to honeybee and bacterial viruses. The final list of speakers is included at the end of this document. Included in the program were 8 short talks selected from the 70 posters presented at the meeting, and a special graduate student session on Monday afternoon was well attended and included 7 talks. This session was initiated as a requirement by the NSF when supporting a previous meeting, and has proven popular enough to continue in the absence of further NSF funding. The poster sessions have always been a strongly supported component of the meeting series and few attendees do not bring work to show. A committee choose notable posters and four were awarded trophies and prizes. An additional activity that started as an experiment and has likewise persisted is the “Meet the Experts” lunch tables where junior attendees (students and post-docs) sign up to dine with selected “Seniors” to give an additional opportunity for discourse. Again, this was popular and well-subscribed.
Specific objectives:
Beyond the mechanics of the meetings – presenting results and methods through talks and posters – the Chairs aimed at providing opportunities for discussion, including sufficient Q&A after each talk, poster sessions for interacting with the numerous labs and their representatives displaying results, social opportunities and free time for less structured encounters. This mix has proven invaluable in meetings since 1990 for fostering collaborations, furthering career opportunities for junior workers, providing an interface with companies that have significant interests in the field, and generally moving the field forward in a productive and efficient manner. The Chairs believe all the major goals of the meeting were very successfully met.

Significant results:
This series has been running biennially since 1990 and continues to be one of the premier meetings for structural virology. It has flourished with, and facilitated advances in, viral genomics, molecular virology, biophysical virology, and structural virology. Attendance at the 2016 conference was very satisfactory (123) despite the additional cost and the new location. Successful fundraising assisted in maintaining the Meeting’s attractiveness to the community, in particular by defraying costs for speakers. The final conference budget was able to support the attendance of 58 speakers who constituted a diverse population with regard to age or stage of career, research focus area, gender and ethnic background, domestic vs. international. The attendee pool included many long-time conference participants, early-stage investigators, and trainees. In addition, several invited speakers were highly respected scientists who had never previously attended but who brought new dimensions to the program and enthusiastically vowed to return for future conferences. These aspects bode well for the long-term health of the meeting series. Significantly, the attendees voted enthusiastically to continue the series with elections of the next Chairs and Vice-Chairs for 2018 and 2020. The group also voted overwhelmingly to request that the next conference be allowed to return to the Steamboat Springs venue. Importantly, trainees had many opportunities to network with established investigators and explore future career options. Further positive results from new collaborations and career trajectories of students and post-docs are not possible to evaluate so soon after the meeting, but have been consequences of the past editions of this series and are expected to have benefited from this year’s meeting.

Key outcomes:
The key outcome was a successful meeting, well attended, and well appreciated so that the next meeting in the series – for 2018 – was enthusiastically endorsed by the attendees. In addition, the Chairs observed an abundance of interactions between attendees that is an expected feature of the Meeting. A post-meeting survey of the attendees showed high marks for the scientific content of the meeting (both talks and posters) as well as the logistics, the venue, and the collegial atmosphere of the meeting. The survey also generated numerous

suggestions for consideration by future conference organizers. In summary, all stated goals were met.

Final list of speakers with their institutional affiliation:
Carol Teschke, University of Connecticut
Mavis Agbandje-McKenna, University of Florida
Sherwood Casjens, University of Utah
Terje Dokland, University of Alabama, Birmingham
Yizhi Jane Tao, Rice University
Tatyana Polenova, University of Delaware
David Veesler, University of Washington
Beth Stroupe, Florida State University
Elif Eren, NIAMS, National Institutes of Health
Rebecca DuBois, University of California, Santa Cruz
Susan Hafenstein, Penn State University College of Medicine
John Wills, Penn State University College of Medicine
Jillian Carmichael, Penn State University College of Medicine
Rachel Cary, State University of New York at Albany
Gunner Johnston, Washington State University
Lindsey Organtini, Penn State University College of Medicine
Nikéa Pittman, University of Florida College of Medicine
Natalia Porcek-Hubbs, Michigan State University
Stacy Webb, University of Kentucky
Ian Molineux, University of Texas
Michael Rossmann, Purdue University
Hector Aguilar-Carreno, Washington State University
Wendy Maury, University of Iowa
Brent Hackett, University of Pennsylvania
Wes Sundquist, University of Utah
Thomas Mettenleiter, Friedrich-Loeffler-Institute
Nihal Altan-Bonnet, NHLBI, National Institutes of Health
Jianming Hu, Penn State University College of Medicine
Elizabeth Wright, Emory University School of Medicine
Becky Dutch, University of Kentucky
Cara Pager, University at Albany, SUNY
Robert Garcea, University of Colorado Boulder
Vijay Reddy, The Scripps Research Institute
Timothy Cross, Florida State University
Audray Harris, NIAID, National Institutes of Health
Chad Petit, University of Alabama at Birmingham
Robert Duda, University of Pittsburgh
Adam Zlotnick, Indiana University
Guillaume Tresset, University of Paris-Saclay
Nicolas Cifuentes-Muñoz, University of Kentucky
Sandra Hope, Brigham Young University
Laura Palomares, Instituto de Biotecnología, UNAM
Roberto Cattaneo, Mayo Clinic
Ariella Oppenheim, Hebrew University-Hadassah Medical School
James Cherwa, Central Alabama Community College
Kenneth Stedman, Portland State University
Kay Choi, University of Texas Medical Branch
Roman Tuma, University of Leeds
Kristin Parent, Michigan State University
Eric Dykeman, University of York
Paul Jardine, University of Minnesota
Wouter Roos, University of Groningen
Fred Homa, University of Pittsburgh School of Medicine
Gino Cingolani, Thomas Jefferson University
Roger Hendrix, University of Pittsburgh
Moriah Szpara, Penn State University

RPPR Final Report
as of 24-Oct-2017

Simon Roux, Ohio State University
Smita Nair, University of Indiana

Training Opportunities: Nothing to Report

Results Dissemination: Nothing to Report

Honors and Awards: Nothing to Report

Protocol Activity Status:

Technology Transfer: Nothing to Report

PARTICIPANTS:

Participant Type: PD/PI
Participant: Rebecca C Craven PhD
Person Months Worked: 1.00 **Funding Support:**
Project Contribution:
International Collaboration:
International Travel:
National Academy Member: N
Other Collaborators:

Virus Structure and Assembly

July 24-29, 2016
Steamboat Springs, CO

Organizers:
James Conway, Ph.D.
University of Pittsburgh
Pittsburgh, PA

Rebecca Craven, Ph.D.
Penn State University College of Medicine
Hershey, PA

Vice Organizers:
Karen Maxwell, Ph.D.
University of Toronto
Toronto, Canada

(Co-Vice Organizer To Be Announced)

Conference Program

Sunday, July 24, 2016

4:00 pm - 9:00 pm	Conference Registration	
6:00 pm - 7:00 pm	Welcome Reception	
7:00 pm - 8:00 pm	DINNER	
8:00 pm - 9:30 pm	**Keynote Speakers**	Page
8:00 pm – 8:15pm	**Welcome**	
Session Chair	**Carol Teschke, University of Connecticut**	
8:15 pm - 8:50 pm	Mavis Agbandje-McKenna, University of Florida *Structural virology as a tool for gene delivery vector optimization*	S-1
8:55 pm - 9:30 pm	Sherwood Casjens, University of Utah *Virions: interchangeable assembly components, diversity and evolution*	S-2

Monday, July 25, 2016 Morning Session

7:30 am - 8:45 am	BREAKFAST	
7:30 am - 1:00 pm	Conference Registration	
9:00 am - 12:00 pm	**Session 1: Virus Architecture - how the pieces fit**	
9:00 am – 9:15 am	**Introduction to the FASEB Meeting**	
Session chair	**Terje Dokland, University of Alabama, Birmingham**	
9:15 am - 9:45 am	Yizhi Jane Tao, Rice University *Structure and function of a nematode-infecting virus*	S-3

9:45 am - 10:15 am	Tatyana Polenova, University of Delaware *Structure and dynamics of HIV-1 capsid assemblies: Insights from an integrated MAS NMR, MD simulations, and density functional theory approach*	S-4
10:15 am - 10:45 am	COFFEE BREAK	
10:45 am - 11:15 am	David Veesler, University of Washington *CryoEM structure of a coronavirus spike glycoprotein trimer*	S-5
11:15 am - 11:45 am	Beth Stroupe, Florida State University *Phages of Sinorhizobium meliloti*	S-6
11:45 am - 12:00 pm	Elif Eren, NIAMS, National Institutes of Health *High resolution structure of hepatitis B virus e-antigen* *(contributed short talk)*	S-7
12:00 am - 12:15 am	Rebecca DuBois, University of California, Santa Cruz *Structural and mechanistic bases for antibody neutralization of human astrovirus* *(contributed short talk)*	S-8

Monday, July 25, 2016 Afternoon

12:30 pm - 1:30 pm	LUNCH and Meet the Experts Table 1: Mavis Agbandje-McKenna and Sherwood Casjens Table 2: Beth Stroupe and Tatyana Polenova

1:45 pm - 4:00 pm Special Session: Graduate Student Talks

Session Chairs	**Susan Hafenstein & John Wills, Penn State University College of Medicine**	
1:45 pm - 2:00 pm	Jillian Carmichael, Penn State University College of Medicine *Mechanistic studies of salubrinal-induced fusion of HSV-1-infected cells*	S-9
2:00 pm - 2:15 pm	Rachel Cary, State University of New York at Albany *Zika virus modulates the landscape of RNA modifications during infection*	S-10
2:15 pm - 2:30 pm	Gunner Johnston, Washington State University *Cytoplasmic motifs in the Nipah virus fusion protein support virus particle assembly and egress*	S-11

2:30 pm - 2:45 pm	Lindsey Organtini, Penn State University College of Medicine *Cryo-EM structures of honey bee deformed wing virus reveal conformational changes linked to genome release*	S-12
2:45 pm - 3:00 pm	Nikéa Pittman, University of Florida College of Medicine *Structural investigation of adeno-associated virus serotype 3b cross-reactive neutralizing epitopes to improve hepatocellular carcinoma therapy*	S-13
3:15 pm - 3:30 pm	Natalia Porcek-Hubbs, Michigan State University *Making sense of the interactions between bacteriophage Sf6 and a secondary receptor, outer membrane protein A*	S-14
3:30 pm - 3:45 pm	Stacy Webb, University of Kentucky *Targeting the HeV F protein TM domain to inhibit viral membrane fusion*	S-15
4:00 pm - 6:00 pm	**Poster Session I**	
4:00 pm - 6:00 pm	Conference Registration	
6:00 pm - 7:15 pm	DINNER	

Monday, July 25, 2016 Evening Session

7:30 pm - 9:45 pm Session 2: Getting into Cells

Session chair	**Ian Molineux, University of Texas**	
7:30 pm - 8:00 pm	Michael Rossmann, Purdue University *Cryo-EM structure of the bacteriophage T4 isometric head at near-atomic resolution*	S-16
8:00 pm - 8:30 am	Ian Molineux, University of Texas *Structural changes of phage ejection nanomachines during infection*	S-17
8:30 pm - 9:00 pm	Hector Aguilar-Carreno, Washington State University *Glycoprotein team burglary: Entry of the deadly zoonotic Nipah virus*	S-18
9:00 pm - 9:30 pm	Wendy Maury, University of Iowa *The role of phosphatidylserine receptors in filovirus entry*	S-19
9:30 pm -9:45 pm	Brent Hackett, University of Pennsylvania *RNASEK is required for internalization of diverse acid-dependent viruses (contributed short talk)*	S-20

Tuesday, July 26, 2016 Morning Session

7:30 am - 9:00 am	BREAKFAST	
7:30 am - 1:00 pm	Conference Registration	

9:00 am - 12:15 pm Session 3: Getting out of Cells

Session Chair	**Wes Sundquist, University of Utah**	
9:00 am - 9:30 am	Thomas Mettenleiter, Friedrich-Loeffler-Institute *Molecular basis of herpesvirus nuclear egress - the prototypic vesicular nucleo-cytoplasmic transport*	S-21
9:30 am - 10:00 am	Nihal Altan-Bonnet, NHLBI, National Institutes of Health *Extracellular vesicles are the Trojan horses of viral infection*	S-22
10:00 am - 10:30 am	Jianming Hu, Penn State University College of Medicine *Secretion of genome-free hepatitis B virions: Implications for virus assembly and clinical management*	S-23
10:30 am - 11:15 am	COFFEE BREAK & **GROUP PHOTO**	
11:15 am - 11:45 am	Elizabeth Wright, Emory University School of Medicine Correlated fluorescence microscopy and cryo-electron tomography of processes associated with HIV-1 replication	S-24
11:45 am - 12:15 pm	Wes Sundquist, University of Utah *Design and characterization of enveloped protein nanoparticles*	S-25

Tuesday, July 26, 2016 Afternoon

12:30 pm - 1:30 pm	LUNCH and Meet the Experts Table 1: Wendy Maury and Michael Rossmann Table 2: Ian Molineux and Wes Sundquist
12:30 pm - 1:30 pm	LUNCH and Virology Ed Round Table Becky Dutch, University of Kentucky Cara Pager, University at Albany, SUNY
4:00 pm - 6:00 pm	**Poster session I continued**
4:00 pm - 6:00 pm	Conference Registration
6:00 pm - 7:15 pm	DINNER

Tuesday, July 26, 2016 Evening Session

7:30 pm - 9:45 pm Session 4: Host-Virus Interactions

Session Chair **Robert Garcea, University of Colorado Boulder**

7:30 pm - 8:00 pm	Robert Garcea, University of Colorado Boulder *Polyomavirus entry: Receptors, pathways, and pathogenesis*	S-26
8:00 pm - 8:30 pm	Vijay Reddy, The Scripps Research Institute *Cryo-EM structure of species-D human adenovirus 26*	S-27
8:30 pm - 9:00 pm	Timothy Cross, Florida State University *The influenza A M2 Protein: Proton channel & viral budding facilitator*	S-28
9:00 pm - 9:30 pm	Audray Harris, NIAID, National Institutes of Health *Structural characterization of influenza vaccine nanoparticles by cryo-electron microscopy*	S-29
9:30 pm - 9:45 pm	Chad Petit, University of Alabama at Birmingham *Structural and functional Insights into Influenza Non-structural Protein 1 (contributed short talk)*	S-30

Wednesday, July 27, 2016 Morning Session

7:30 am - 9:00 am	BREAKFAST
7:30 am - 1:00 pm	Conference Registration

9:00 am - 12:15 pm Session 5: Virion Assembly - Putting the Pieces Together

Session Chair **Robert Duda, University of Pittsburgh**

9:00 am - 9:30 am	Robert Duda, University of Pittsburgh *Don't touch that salt bridge, it makes my head distort*	S-31
9:30 am - 10:00 am	Carolyn Teschke, University of Connecticut *Portal protein: the business end of dsDNA viruses*	S-32
10:00 am - 10:30 am	Adam Zlotnick, Indiana University *Simple mechanisms of assembly lead to complex architectures*	S-33
10:30 am - 11:00 am	COFFEE BREAK	

11:00 am - 11:30 am	Terje Dokland, University of Alabama at Birmingham *Staphylococcal bacteriophages and their role in mobilization of S. aureus pathogenicity islands*	S-34
11:30 am - 12:00 am	Guillaume Tresset, University of Paris-Saclay *What can we learn from the disassembly of icosahedral viral capsids?*	S-35
12:00 am - 12:15 am	Nicolas Cifuentes-Muñoz, University of Kentucky *Imaging the replication and assembly of the human metapneumovirus (HMPV) genome* *(contributed short talk)*	S-36

Wednesday, July 27, 2016 Afternoon

12:30 pm - 1:30 pm	LUNCH
1:00 pm - 4:00 pm	Optional Group Activity - Strawberry Park Hot Springs
4:00 pm - 6:00 pm	**Poster session II**
4:00 pm - 6:00 pm	Conference Registration
6:00 pm - 7:15 pm	DINNER

Wednesday, July 27, 2016 Evening Session

7:30 pm - 9:45 pm Session 6: Viruses as Tools

Session Chair **Adam Zlotnick, Indiana University**

7:30 pm - 8:00 pm	Sandra Hope, Brigham Young University *Phages to fight American foulbrood*	S-37
8:00 pm - 8:30 pm	Laura Palomares, Instituto de Biotecnología, UNAM *Properties of nanobiomaterials fabricated with rotavirus recombinant proteins*	S-38
8:30 pm - 9:00 pm	Roberto Cattaneo, Mayo Clinic *New viruses for cancer therapy: the measles paradigm*	S-39
9:00 pm - 9:30 pm	Ariella Oppenheim, Hebrew University-Hadassah Medical School *Signaling pathways elicited by SV40 harnessed for therapy of critical clinical conditions*	S-40

9:30 pm - 9:45 pm	James Cherwa, Central Alabama Community College *Biochemical analysis of a dominant lethal scaffolding protein and evolutionary mechanisms of resistance* *(contributed short talk)*	S-41

Thursday, July 28, 2016 Morning Session

7:30 am - 9:00 am	BREAKFAST
7:30 am - 12:00 pm	Conference Registration

9:00 am - 12:15 pm Session 7: Viruses and Nucleic Acids I

Session Chair **Yizhi Jane Tao, Rice University**

9:00 am - 9:30 am	Karin Musier-Forsyth, Ohio State University *Unexpected role of aminoacyl-tRNA synthetases in the HIV-1 lifecycle*	S-42
9:30 am - 10:00 am	Kenneth Stedman, Portland State University *Structure and genetic analysis of Sulfolobus fuselloviruses*	S-43
10:00 am - 10:30 am	Kay Choi, University of Texas Medical Branch *Flavivirus genome replication by NS5 polymerase*	S-44
10:30 am - 11:00 am	COFFEE BREAK	
11:00 am - 11:30 am	Roman Tuma, University of Leeds *Contrasting roles of RNA-protein interactions in the assembly of ssRNA and dsRNA viruses*	S-45
11:30 am - 12:00 pm	Kristin Parent, Michigan State University *Host recognition and entry for the Shigella phage Sf6*	S-46
12:00 pm - 12:15 pm	Eric Dykeman, University of York *Evidence for a packaging-signal mediated nucleation complex in bacteriophage MS2* *(contributed short talk)*	S-47

Thursday, July 28, 2016 Afternoon Session

12:30 pm - 1:30 pm	LUNCH and Meet the Experts Table 1: Bob Garcea and Carol Teschke Table 2: Karin Musier-Forsyth and Terje Dokland

1:30 pm - 4:00 pm Session 8: Viruses and Nucleic Acids II

Session Chair	**Paul Jardine, University of Minnesota**	
1:30 pm - 2:00 pm	Paul Jardine, University of Minnesota *Bacteriophage DNA packaging as a model for ring motors and polymer dynamics*	S-48
2:00 pm - 2:30 pm	Wouter Roos, University of Groningen *Probing viral assembly and mechanics by a combination of biophysical techniques*	S-49
2:30 pm - 3:00 pm	Fred Homa, University of Pittsburgh School of Medicine *Nuclear events in the assembly of alphaherpesviruses*	S-50
3:00 pm - 3:15 pm	Gino Cingolani, Thomas Jefferson University *The signal for termination of headful packaging is a DNA-dependent symmetrization of portal protein* *(contributed short talk)*	S-51

Thursday, July 28, 2016 Evening

3:15 pm - 3:45 pm	**Business Meeting**
4:00 pm - 6:00 pm	**Poster Session II continued**
4:00 pm - 6:00 pm	Conference Registration
6:00 pm - 7:30 pm	DINNER
8:00 pm -	Poster prizes (supplied by Virology/Elsevier) Evening festivities @ The Cabin Bar

Friday, July 29, 2016 Morning Session

7:30 am - 9:00 am	BREAKFAST	
7:30 am - 12:00 pm	Conference Registration	
9:15 am - 11:30 am	**Session 9: Virus Evolution and Diversity**	
Session Chair	**Roger Hendrix, University of Pittsburgh**	
9:15 am - 9:45 am	Moriah Szpara, Penn State University *Impacts of sequence diversity in isolates of human herpes simplex virus*	S-52
9:45 am - 10:15 am	Roger Hendrix, University of Pittsburgh *Evolution and genomics of jumbophages*	S-53
10:15 am - 10:45 am	COFFEE BREAK	
10:45 am - 11:15 am	Simon Roux, Ohio State University *Exploration, classification, and characterization of environmental viral genomes*	S-54
11:15 am - 11:30 am	Smita Nair, University of Indiana *Encapsidation of APOBEC3A in HBV and evidence of editing during reverse transcription* *(contributed short talk)*	S-55
12:00 pm	LUNCH (to go) & DEPARTURE	